EMERGENCY/PROCESS UPSET FLARING MANAGEMENT:

MODELLING GUIDANCE

Alberta Environment

Emergency/Process Upset Flaring Management:

Modelling Guidance

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PREFACE

The Alberta Environment (AENV) Emergency/Process Upset Flaring Management: Modelling Guidance (Guideline) is intended for flare operations that require an *Environmental Protection and Enhancement Act* (EPEA) approval, or that operate under a Code of Practice for emissions to the atmosphere.

Alberta Environment has developed the Guideline to ensure consistency in the use of dispersion models for regulatory applications in Alberta. The practices recommended within this guideline are a means to ensure that these objectives are met.

The Guideline outlines Alberta Environment's dispersion modelling requirements and methods. Although some specific information on models is given, the user should refer to user guides and reference materials for the model of interest for further information on dispersion modelling. The Guideline will be reviewed regularly to ensure that the best available tools are being used to predict air quality.

Additional information relevant to dispersion models can be located at these web pages:

http://www.gov.ab.ca/env/air/
http://www.gov.ab.ca/env/air/airqual/airmodelling.html
http://www.gov.ab.ca/env/air/airqual/metdata.html
http://www.epa.gov/scram001
http://www.cmc.ec.gc.ca

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1.0 INTRODUCTION

The primary use of this document is intended for any facility that requires an *Environmental Protection and Enhancement Act* (EPEA) Approval. However, this document could be adapted and utilised for a wide array of facilities and/or emergency or upset conditions.

In the event of an upset condition in a facility, flaring of large volumes of gas can occur in a short period of time. Designing emergency flare stacks so that the Alberta Ambient Air Quality Guidelines (AAAQG) are met can be difficult since parameters such as duration and flow rates will vary depending on the nature of the emergency or upset flaring event.

Furthermore, the shortest averaging time that most models predict for is 1-hour, while often, emergencies or flaring events can be much shorter in duration. Secondly, these emergency or upset flaring events are intermittent. There must be a means to account for the likelihood of whether flaring will occur during a period of worst-case meteorology.

Short-term AAAQG concentrations for SO_2 could be met on a predictive basis if the relationships between the emissions, flaring duration, and ambient concentration were determined for each facility. The relationships of these parameters can be plotted on charts, and made easily accessible to operators, for their use during a flaring event. This would allow them to make appropriate decisions as to when and how flaring will be carried out to meet ambient guidelines by adjustment of the duration, flow, or type of fuel that is being flared.

1.1 Purpose of the Air Quality Modelling Guideline

This document outlines a methodology for dispersion modelling that should be used to determine appropriate flaring management practices. The methodology has been developed to (i) ensure that consistency is maintained in the modelling for each facility. (ii) All facilities are evaluated on the same predictive basis. There are differing scientific views on many methods of modelling, and all facilities are designed differently. However, it is essential that the overall methodology for assessment is consistent to allow for simple comparison between different facilities.

This modelling must be carried out to show that due diligence to protect the environment during upset conditions was considered in any EPEA Application relating to emergency or upset flaring. For further details on dispersion modelling, please refer to the Air Quality Model Guidelines (AQMG) (AENV, 2003) as amended.
http://www3.gov.ab.ca/env/air/airqual/AirQualityModelGuidelineOct00.pdf

1.2 Statutory Authority

This guideline is issued by Alberta Environment, under Part 1, 14 (4), the *Environmental Protection and Enhancement Act* 1992 (EPEA). This document replaces all previous versions of the Alberta Emergency/Process Upset Flaring Management: Modelling Guidance. This guideline should be read in conjunction with the Alberta Ambient Air Quality Guidelines and the Air Monitoring Directive.

2.0 ASSESSMENT

2.1 Source Parameters

The flare design and performance should meet the requirements of Alberta Energy and Utilities Board (AEUB) Guide 60 as amended. http://www.eub.gov.ab.ca/BBS/requirements/Guides/g60-1999.htm

The following parameters must be determined as input into the air dispersion models:

Source Information Required:

- Stack Height (m)
- Emission Rate (g/s)
- Temperature (K)
- Exit Velocity (m/s)
- Stack top Diameter (m)

Screen3 utilizes heat radiation loss of 45% when calculating ground level concentration. Such heat radiation loss is very conservative. Heat loss of 25% is a recommended value (AENV, 1999). To account for the change in heat radiation loss of 25% in Screen3, the point source option should be used as opposed to the flare option. Refined air quality models described in AQMG do not have the capability to model flares directly, therefore, pseudo stack parameters (e.g. height, diameter) should be calculated for the flare, to compensate for the flame height, and initial dispersion from the flame. These parameters can be calculated in a number of different ways. The selected method is left up to the modeller, but must be justifiable. AENV has prepared a spreadsheet that calculates the pseudo-parameters. It is posted on http://www3.gov.ab.ca/env/air/airqual/airmodelling.html

The spreadsheet is called FlrCalcs3.exe and is in a self-extracting executable. The format is Excel 95/5.0.

2.2 Adjustment of Predictions to Shorter-Averaging Times

If the flaring period is more than 1-hour the flare will be modeled as a continuous source and the model predictions are directly compared with AAAQG. However, if the flare duration is less than 1-hour the predicted ground level concentrations must be first converted to 1-hour equivalent and then compared with AAAQG.

There are numerous methods to convert a 1-hour predicted concentration. A synopsis of the different methods is presented with an example assuming a 10- minute release. Sakiyama (1984) and Gifford (1975) show some further examples than what is displayed here.

1) Assume that the total release occurs over 10-minutes. The substance rate can be divided by 6, and modelled for the entire hour, and the resulting prediction can be directly compared with a 1-hour standard.

2) Model the release as though the gas is released over the entire hour. Assume that the resulting concentration is what would actually occur over a 10-minute interval, for the rest of the hour, the observed concentration would be zero (Once the flare release stops. The resulting prediction from the model can be divided by 6 to obtain the actual 1-hour observed concentration.

Concentration (1hr) = Concentration (Predicted)*duration (seconds)/3600s

E.g. Emission Rate of 50g/s, over 10 min (100% Processing Capacity)
Maximum Predicted Concentration of 5000 μg/m^3 from model output
[5000] μg/m^3 *600/3600 = [833] μg/m^3 is the hourly predicted concentration.

2.3 General Methodology

The model predictions should be adjusted to reflect the duration of the flare as indicated in Section 2.2, if the emergency flare duration is less than 1-hour. If the model predictions, after being adjusted, indicate potential exceedances for stability classes other than (A) stability class, higher heating values should be examined prior to further analysis of the individual stability class maximums.

Ground level concentrations can be calculated for various durations. If the predicted concentrations are greater than the AAAQG, the heating value should be adjusted by adding fuel gas until the guideline is met, or the results are satisfactory within the reasonable bounds of the flaring parameters. If this is not possible, the maximums in each stability class should be analyzed.

If the resultant concentrations are below the guideline value for all stabilities except (A), which is a very rare stability class in most of Alberta (0-2%) (Angle and Sakiyama, 1991), then no further modelling is necessary. The reason for this is that the likelihood of having an emergency or upset flaring event in combination with (A) stability class is low. The conservatism in the model, combined with the low risk of exceeding, is acceptable for design purposes. Once air quality modelling is completed, concentration plots should be generated as outlined in Figure 1.

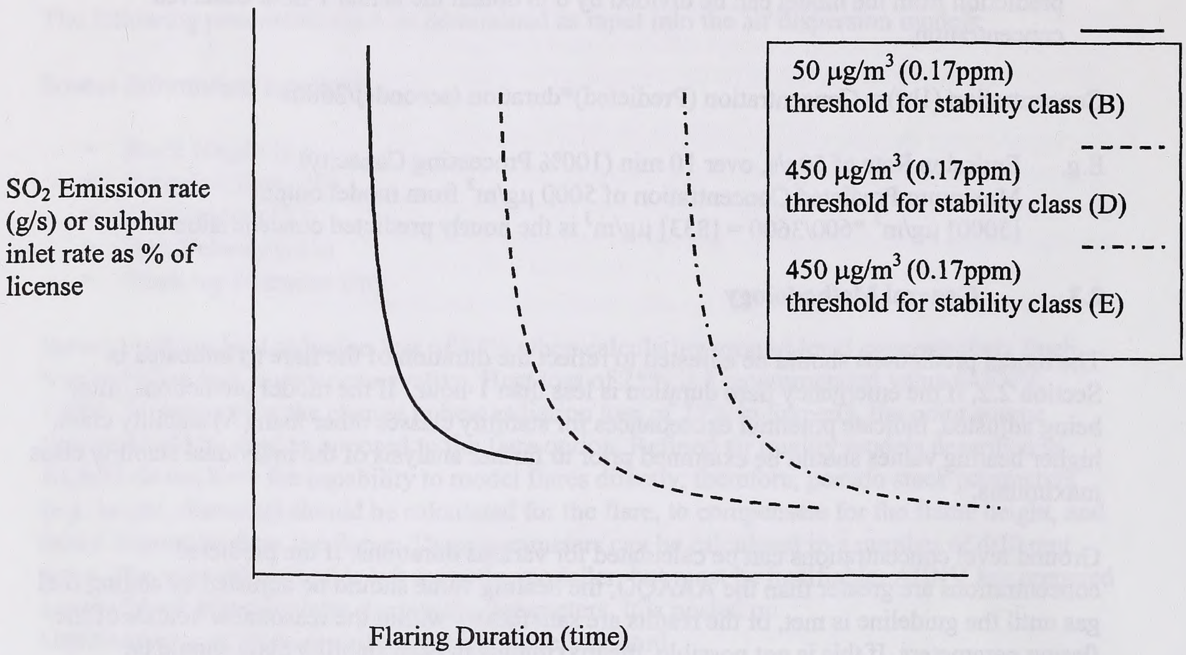

Figure 1. Example plot for sour or acid gas flaring for different stability classes and specific heating value

3.0 FLARING DURATION LIMITS

3.1 Guideline Plots for Various Conditions

The amount of plots created may vary depending on the nature of the operation. At a minimum, plots for stabilities (B- unstable), (D - neutral), and (E - stable) should be made for the worst-case flaring event. This should be sufficient to give an operator an indication as to how flaring can be conducted within environmentally accepted manner. An example of the plots can be found on Figure 1.

The plots should be supplied to the operators, along with a description of stability conditions. The operators will then have the ability to assess the most appropriate way to carry out the flaring, once health, safety and plant integrity considerations are under control.

3.2 Assessing Stability Class

Stability classes are means used to describe atmospheric turbulence. The most commonly used stability categories are the Pasquill-Gifford (P-G) Stability Categories. They range from category (A) very unstable, to category (F) very stable. There are different methods in which stability can be calculated, and much will depend on the availability of meteorological data. For many facilities in Alberta, sufficient real-time meteorological data to calculate stability will not be available at the time of an emergency or upset flaring event. Therefore, the operator will have to use his or her own discretion as to what the most appropriate stability class to use. Table 1 is a broad guide to determining stability class. The table is meant for operational purposes only. It is not certain that the conditions will reflect the state of turbulence in the atmosphere at a particular point in time.

Table 1. Broad Guide to Stability

Assumed Stability Class	General Condition of the Atmosphere
a) Summer	**(April – September)**
Unstable (A, B or C)	Relatively Clear Skies, Calm conditions, light winds, during daytime
Neutral D	Overcast skies (Day or Night-time*) Also for any period with stronger winds
Stable (E or F)	Night-time*, calm to light winds
b) Winter	**(October – March)**
Unstable (A, B or C)	Unusually warm, clear daytime conditions, light winds
Neutral D	All overcast conditions, or strong winds (Chinooks included)
Stable (E or F)	Assume for any other condition

*Night-time refers to 1-hour before sunset to 1-hour after sunrise

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